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BOULDER, COLORADO 80302

DEPARTMENT OF CHEMISTRY

April 24, 1969

Professor Joshua Lederberg
Department of Genetics
Stanford University Medical Center
Stanford, California 94305

Dear Professor Lederberg:

Your letter of April 14 has only just reached me, having been forwarded to this address from Yale. I can answer it in part with some of the enclosed reprints. These include a report on some measurements of terrestial $C^{14}O$, and studies on reaction of atomic carbon with inorganic molecules. I also send a review on carbon atom reactions with organic molecules. (We have published quite a few papers in the latter area, but the review will probably provide all the information you want).

Your interest in carbon monoxide "metabolism" has started me thinking again about some ideas which arose from this old work of ours. The hypothesis involved is highly speculative and since my main interest is in the nature of simple chemical reaction, I haven't done much with it. However the few people to whom I've mentioned it, including Willard Libby and Charles Barth, could tell me of no obvious fallacy.

The idea is simply that on CO_2 rich planets, like Mars, the life cycle is likely to be based on the metabolic oxidation of carbon monoxide. Solar UV radiation dissociates CO_2.

$$CO_2 \rightarrow CO + O$$

$$O + O + M \rightarrow O_2 + M$$

Reoxidation of CO to CO_2 will then occur in a living organism.

As mentioned in my article, as cited by you, metabolism of CO is possible: that is just what B. Oligocarbophilus does. Moreover, and this is the critical point, the chemical machinery necessary to extract metabolic energy from the oxidation of CO should be capable of being much simpler than that for photosynthesis. That would suggest that this metabolic cycle might be a primitive precursor to the photosynthetic cycle. Conceivably when the atmosphere of earth was rich in CO_2, rather than O_2, terrestrial life also might then have developed through a CO energy cycle.

Another advantage of the CO cycle to primitive life is that it means that the organism can stay out of direct sunlight. This could be quite helpful as chemical combinations which would be unstable with respect to solar photolysis could be employed.

If this hypothesis were correct then it would provide the solution to a rather vexing problem. As I mentioned, citing Bates, in my 1960 article, it is difficult to conceive of a sufficiently rapid way to recombine CO and O_2 on earth. The same problem seems to exist in regard to the Martian and Venusian atmosphere. The rate of photolysis of CO_2 on Mars by light of wavelength less than 1700 Å is substantial. No good "inorganic" recombination mechanism has been proposed. Why then is the steady state not predominantly CO and O_2 rather than CO_2?

The main drawback of the CO cycle is that it would make use of only a small fraction of solar radiant energy (that part at < 1700 A). While it might, therefore be appropriate for primitive life forms, it should be overwhelmed by photosynthesis as conditions permit and the more sophisticated chemical machinery necessary evolves.

I would be most interested in hearing of your views on this idea.

Sincerely,

Richard Wolfgang

Richard Wolfgang
Professor of Chemistry

P. S. Please address me as above until June 15

Enclosures

cc: Willard Libby
Charles Barth

RW:cl